CHARLES DARWIN UNIVERSITY

Family Name	
Given Names	
Student Number	
Teaching Period	Semester 1, 2016

FINAL EXAMINATION	**DURATION**
ENG151 – Statics	Reading Time: **10** minutes Writing Time: **180** minutes

INSTRUCTIONS TO CANDIDATES

EXAM CONDITIONS

<u>You may begin writing from the commencement of the examination session.</u> The reading time indicated above is provided as a guide only.

This is a CLOSED BOOK examination

Any non-programmable calculator is permitted

No handwritten notes are permitted

No dictionaries are permitted

ADDITIONAL AUTHORISED MATERIALS	EXAMINATION MATERIALS TO BE SUPPLIED
No additional printed material is permitted	1 x 20 Page Book

THIS EXAMINATION IS PRINTED DOUBLE-SIDED.

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Question 1. (20 marks)

1.1 (2 marks)

Consider a motor vehicle at rest on a steep incline – it is prevented from sliding down the incline by friction between the tyres and the road surface. If the steepness of the incline is gradually increased, at some point the car will begin to slide down. Will fitting wider tyres of the same compound of rubber to the car stop it from sliding? Explain your answer.

1.2 (1 mark)

An engineer wishes to design a beam as part of the structural design for a new building. What is the first step that should be performed?

1.3 (2 marks)

In a practical experiment which compared measured forces with theoretically determined forces, it was found that there was a difference of up to 15%. Provide reasons for this variation, and comment on how these variations are allowed for when designing a structure.

1.4 (2 marks)

A student has drawn an FBD of a machine, and found that there are too many unknown forces to be analysed using the equations of equilibrium. What steps could she or he take to possibly allow the unknown forces to be analysed?

1.5 (2 marks)

In statics we have learned how to analyse simple trusses. Give two examples of situations in which a truss might be used and explain why trusses are important in engineering.

1.6 (1 mark)

Describe two graphical methods of adding forces. Why are these methods usually not used?

1.7 (1 mark)

The centroid of a body always coincides with the body's centre of mass – true or false?

1.8 (3 marks)

Which are the zero force members in the truss shown in Figure 1?

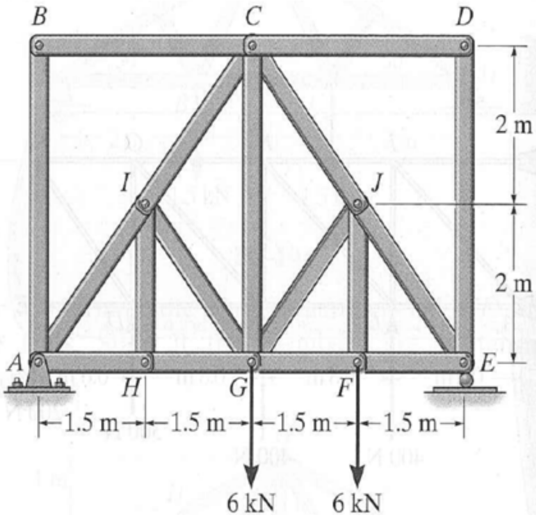


Figure 1

1.9 (5 marks)

For the object shown in Figure 2:

1.9.1 Which are the two force members?

1.9.2 Draw the free body diagram for part AEDC

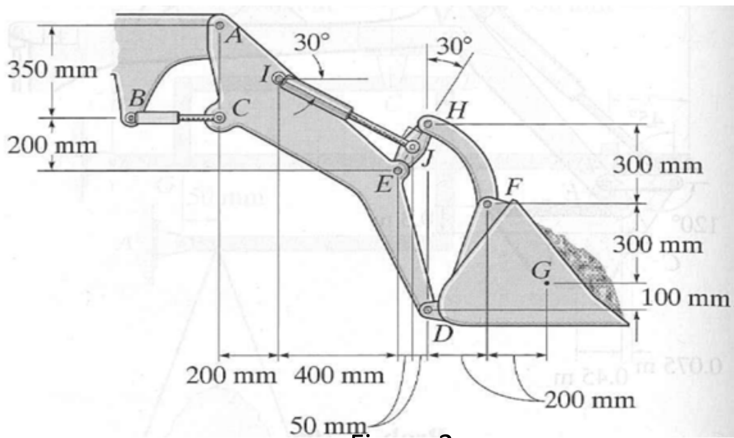


Figure 2

1.10 (1 mark)

"Real" structures are often not statically determinant. Why is this so?

Question 2. (16 marks)
Draw the shear force and bending moment diagrams for the beam shown in Figure 3, including the value and location of all maximum values.

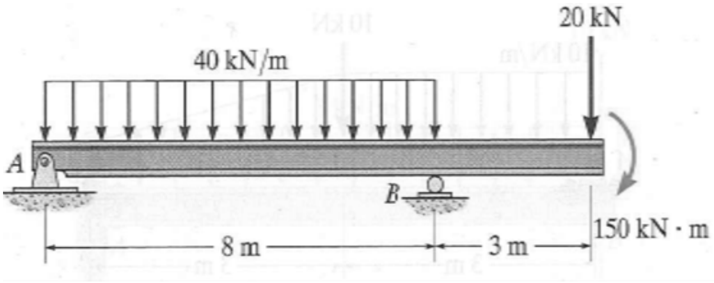


Figure 3

Question 3. (16 marks)

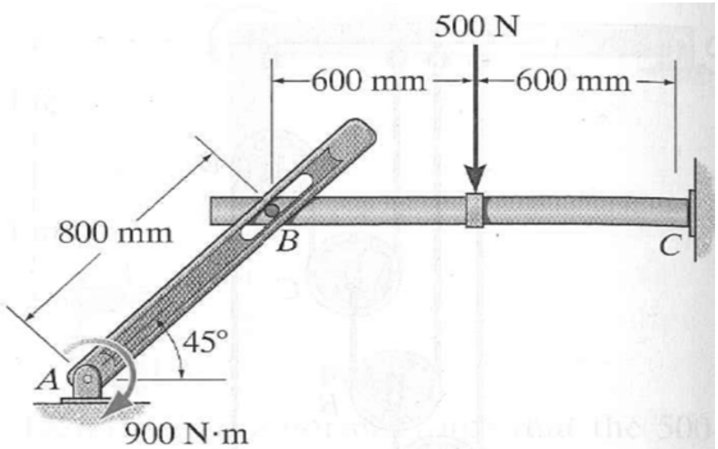


Figure 4

For the mechanism shown in Figure 4, determine the reactions at support points A and C.

Question 4. (20 marks)

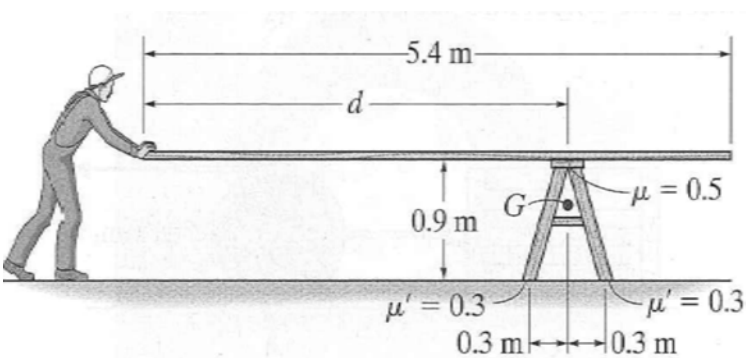


Figure 5

A board is pushed horizontally over the top of a saw horse as shown in Figure 5. Determine if the saw horse will remain in its original position, slip or tip as the board is pushed forwards when d = 4.2m.

The board has a uniform weight of 50N/m and the saw horse a weight of 75N. The centre of gravity of the saw horse is at G and coefficients of static friction are as shown.

Question 5. (12 marks)

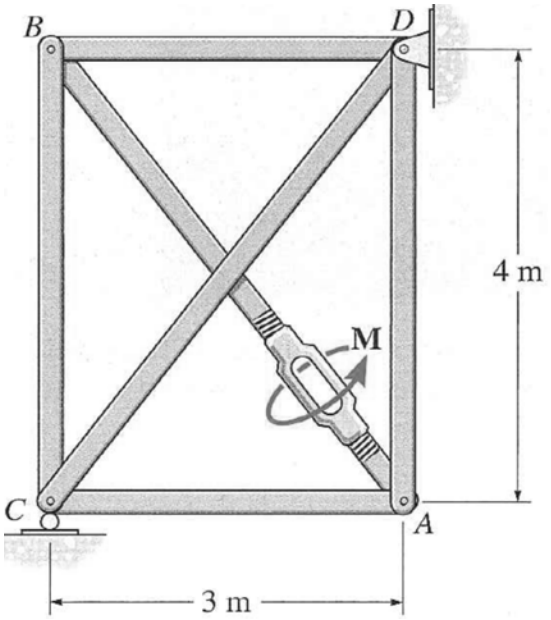


Figure 6

For the frame shown in Figure 6, a torque of M = 10 Nm is applied to the turnbuckle, drawing the screws closer together and so inducing tension in member AB.

Determine the force in each member of the frame.

The coefficient of friction between the square threaded screws and the turnbuckle is 0.5, and the screws have an average diameter of 12mm and a lead of 3mm.

Assume the external reaction forces at points C and D are zero.

Question 6. (16 marks)

For the loaded truss shown in Figure 7, determine the forces in members BG, BC and HG.

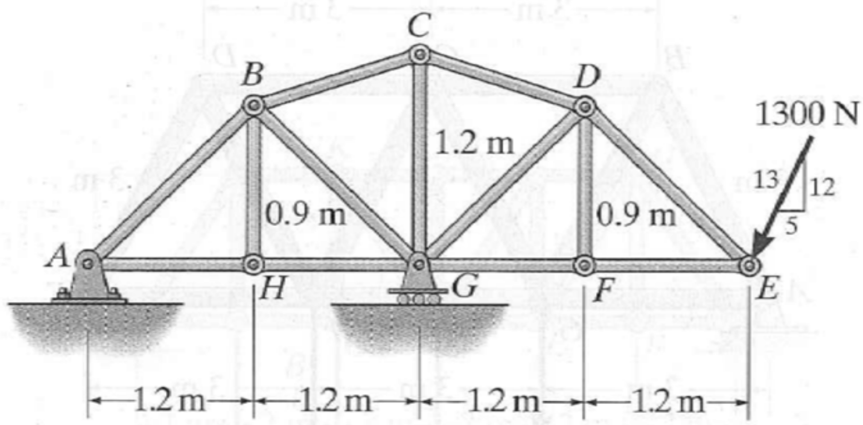


Figure 7

Formula Sheet

$$\Sigma M_O = 0$$
$$\Sigma F_V = 0$$
$$\Sigma F_H = 0$$

$$A\bar{y} = \int y\,dA$$
$$A\bar{x} = \int x\,dA$$

$$I_x = \bar{I}_x + Ad_x^2$$
$$I_y = \bar{I}_y + Ad_y^2$$

$$A\bar{y} = \Sigma A_n \bar{y}_n$$
$$A\bar{x} = \Sigma A_n \bar{x}_n$$

$$m + 3 \le 2j$$

$$dV = -w\,dx$$
$$dM = V\,dx$$

raise

$$M = Wr\tan(\phi + \alpha)$$

lower

$$M = Wr\tan(\phi - \alpha)$$

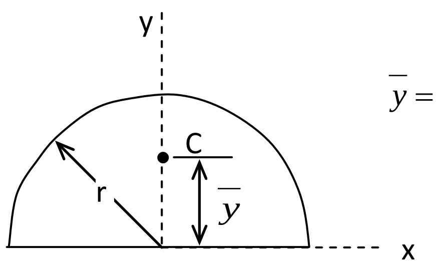
$$\mu = \frac{F_{\max}}{N}$$
$$\varphi = \tan^{-1}\mu$$

if $\quad M_O = r \times F$

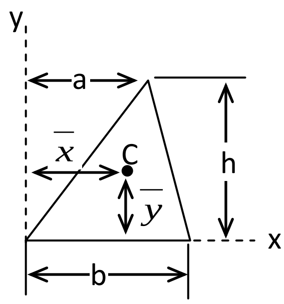
then $$M_O = \begin{array}{ccc} i & j & k \\ r_x & r_y & r_z \\ F_x & F_y & F_z \end{array}$$

$$\tan\alpha = \frac{L}{2\pi r}$$

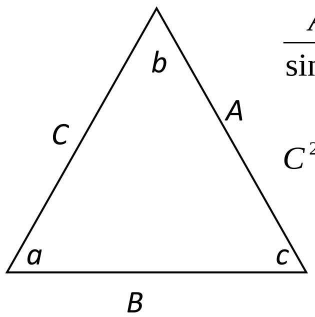
$$T_2 = T_1 e^{\mu\beta}$$



$$\bar{y} = \frac{4r}{3\pi}$$

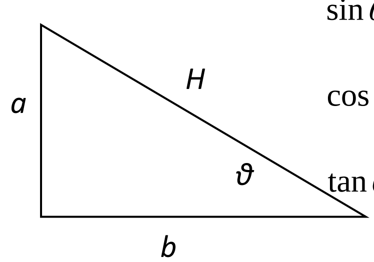


$$\bar{x} = \frac{a+b}{3}$$
$$\bar{y} = \frac{h}{3}$$



$$\frac{A}{\sin a} = \frac{B}{\sin b} = \frac{C}{\sin c}$$

$$C^2 = A^2 + B^2 - 2AB\cos c$$



$$\sin\theta = \frac{a}{H}$$
$$\cos\theta = \frac{b}{H}$$
$$\tan\theta = \frac{a}{b}$$